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# *Indian Standard*

# SPECIFICATION FOR PORTABLE ELECTRIC MOTOR-OPERATED TOOLS

## PART 1 GENERAL REQUIREMENTS AND TESTS

## ( *First Revision* )

UDC 621·9-83-182·4 : 621·313·13 : 620·1

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**Gr 10** *February* 1986

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## *( First Revision )*

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# AMENDMENT NO.1 JANUARY 1993
# TO
# IS 4665 ( Part 1 ) : 1984 SPECIFICATION FOR PORTABLE ELECTRIC MOTOR-OPERATED TOOLS

## PART 1 GENERAL REQUIREMENTS AND TESTS

*( First Revision )*

( *Page* 21, *clause* **15.2** ) — Substitute the following for the existing last sentence of the clause:

'The cross-sectional area of conductor and the diameter of wires in any conductor shall comply with Table 3.'

( *Page* 21, *Table* 3 ) :

a) ( *Title* ) — Substitute the following for the existing title of the table:

'CROSS-SECTIONAL AREA OF CONDUCTORS FOR FLEXIBLE CORDS/CABLES'

b) ( Column 3 ) — Substitute the following for the existing col 3 of the table:

| 'Maximum Diameter of Wires in Conductor (3) mm |
|---|
| 0.21 |
| 0.21 |
| 0.21 |
| 0.21 |
| 0.26 |
| 0.26' |

( ETD 15 )

# *Indian Standard*

# SPECIFICATION FOR PORTABLE ELECTRIC MOTOR-OPERATED TOOLS

## PART 1 GENERAL REQUIREMENTS AND TESTS

## *( First Revision )*

## 0. FOREWORD

**0.1** This Indian Standard ( Part 1 ) ( First Revision ) was adopted by the Indian Standards Institution on 21 February 1984, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** This standard ( Part 1 ) was first issued in 1968. It has now been revised to update the requirements on the basis of the latest trends in this field at the international level.

**0.3** This standard is intended primarily to establish a satisfactory standard of safety when the tool is used under normal conditions.

**0.4** This standard does not cover tools intended to be used in vehicles or onboard ships or aircrafts and the like, or in hazardous locations, for example, where explosions are likely to occur. Special construction may be required for such applications.

**0.5** This standard ( Part 1 ) covers requirements common to all portable motor-operated tools. Part 2 of the standard deals with specific requirements appropriate to different tools.

**0.6** In preparing this standard, assistance has been derived from the following:

CEE Publication 20-1973 Specification for hand held portable motor-operated tools ( *second revision* ). International Commission on Rules for the Approval of Electrical Equipment ( CEE ).

BS 2769 : 1964 Portable electric motor-operated tools. British Standards Institution.

**0.7** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## 1. SCOPE

**1.1** This standard ( Part 1 ) covers general requirements and tests for all insulated, double-insulated and functionally insulated portable electric motor-operated tools (*see* **4.1** ) for indoor or outdoor use and tools which, although primarily intended to be used as fixed tools, can be used as portable tools or can easily be carried from one place to another. It applies to tools designed for operation on voltages not exceeding 250 V ac and/or dc for hand-held tools or 440 V dc or polyphase ac for other tools.

**1.2** This standard ( Part 1 ) does not cover accessories or attachments used with tools, bench grinders, household appliances and toys. It also does not cover tools intended to be used in vehicles or on board ships or aircrafts.

**1.3** The specific requirements of tools are covered in Part 2 of this standard.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply.

**2.1 Rated Voltage** — The voltage assigned to the tool by the manufacturer.

**2.2 Rated Voltage Range** — The voltage ( ac or dc ) limits assigned to the tool by the manufacturer.

**2.3 Rated Frequency** — The frequency assigned to the tool by the manufacturer.

**2.4 Rated Frequency Range** — The frequency range assigned to the tool by the manufacturer.

**2.5 Rated Current** — The current assigned to the tool by the manufacturer.

**2.6 Rated Input** — The power input assigned to the tool by the manufacturer.

---

*Rules for rounding off numerical values ( *revised* ).

**2.7 Portable Electric Motor-Operated Tool ( Hereinafter Referred to as Tool )** — An electric motor-operated machine so designed that the motor and the machine form an assembly which can be carried by hand to the piece to be worked upon or to its place of operation.

**2.8 Hand-Held Tool** — An electric motor-operated tool intended to be held by hand or suspended during normal operation.

Note — Hand-held tools may be provided with a flexible shaft, the motor being fixed or portable. Hand-held tools may also have provision for mounting on a support.

**2.9 Basic Insulation** — An insulation applied to live parts to provide basic protection against electric shock.

Note 1 — Basic insulation does not necessarily include insulation used exclusively for functional purposes.

Note 2 — The insulating properties of lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, beads and sealing compound shall not be relied upon to give the required potection against accidental contact with live parts.

**2.10 Functionally Insulated Parts** — Metal parts that are separated from live parts by basic insulation only.

**2.11 Supplementary Insulation ( Protective Insulation )** — An independent insulation applied in addition to the basic insulation in order to ensure protection against electric shock in the event of a failure of the basic insulation.

**2.12 Double Insulation** — Insulation comprising both basic insulation and supplementary insulation.

**2.13 Reinforced Insulation** — A single insulation system applied to live parts which provides a degree of protection against eletcric shock equivalent to double insulation under the conditions specified in this standard.

Note — The term 'insulation system' does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

**2.14 Class I Tool** — A tool in which protection against electric shock does not rely on basic insulation only, but which includes extra safety in that accessible conductive parts are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation.

Note 1 — Class I tools may have parts with double insulation or reinforced insulation, or parts operating at safety extra-low voltage.

Note 2 — For tools intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

**2.15 Class II Tool** — A tool in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.

**2.15.1** *All-Insulated ( Class II A ) Tool* — A tool having a durable and substantially continuous enclosure of insulating material which envelopes all metal parts, with the exception of small parts, such as name plates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation.

**2.15.2** *Metal-Encased ( Double-Insulated ) ( Class II B ) Tool* — A tool having a substantially continuous metal enclosure, in which double insulation is used throughout except for parts where, because the application of double insulation is manifestly impracticable, reinforced insulation is used.

NOTE 1 — A tool could be a combination of the types specified in **2.15.1** and **2.15.2** and still be called a Class II tool.

NOTE 2 — The enclosure of an insulation-encased Class II tool may form a part or the whole of the supplementary insulation or of the reinforced insulation.

NOTE 3 — If a tool with double insulation and/or reinforced insulation throughout has an earthing terminal or earthing contact, the tool is deemed to be of Class I.

NOTE 4 — Class II A tool may have parts operating at safety extra-low voltage.

**2.16 Class III Tool** — A tool designed for operation at safety extra-low voltage ( *see* **2.18** ), and which has no circuits, either internal or external, which operate at a voltage other than safety extra-low voltage.

**2.16.1** Tools intended to be operated at safety extra-low voltage and having internal circuits which operate at a voltage other than extra-low voltage ( *see* **2.17** ) are not included in the classification and are subject to additional requirements; these requirement are under consideration.

**2.17 Extra-Low Voltage** — A voltage between any two conductors or between any part of either conductor and earth, not exceeding 32 V.

**2.18 Safety Extra-Low Voltage** — A nominal voltage not exceeding 32 V between conductors and between conductors and earth or, for three-phase supply, not exceeding 18·5 V between conductors and neutral, the no-load voltage not exceeding 38 V and 22 V respectively.

NOTE 1 — When safety extra-low voltage is obtained from the supply mains it must be through a safety isolating transformer or a convertor with separate windings.

NOTE 2 — The voltage limits specified are based on the assumption that the safety isolating transformer is operated at its rated supply voltage.

**2.19 Normal Load** — A load applied to the tool so that the stress imposed corresponds to that occurring under normal conditions of use, any marking of short-time or intermittent operation being observed unless otherwise specified in the particular specification.

**2.20 Body of the Tool** — The term 'body' includes all accessible metal parts, shafts, handles, knobs, grips and the like and metal foil in contact with accessible surfaces of insulating material which can be touched by the test finger specified in IS : 1401-1970*. It does not include inaccessible metal parts.

**2.21 Detachable Part** — Any part that can be removed without the aid of a tool, such as screwdriver, or any other object.

**2.22 Rated Operating Time** — The duration of time of operation assigned to the tool by the manufacturer.

**2.23 Continuous Operation** — Operation of the tool under normal load for an unlimited duration.

**2.24 Short-Time Operation** — Operation of the tool under normal load for a specified period, starting from ambient conditions, the interval between two successive periods of operation being sufficiently long to allow the tool to cool down to approximately ambient conditions.

**2.25 Intermittent Operation** — Operation of the tool in a series of specified identical cycles, each cycle being composed of a period of operation under normal load followed by a rest period with the tool running idle or switched off.

**2.26 Creepage Distance** — The shortest path between two conductive parts, or between a conductive part and the bounding surface of the tool, measured along the surface of the insulating material.

NOTE — If a barrier is interposed and this is in two parts which are not cemented together, the distance is measured through the joint.

**2.27 Clearance** — The shortest distance between two conductive parts, or between a conductive part and the bounding surface of the tool, measured through air.

NOTE 1 — The bounding surface of the tool is the outer surface of the enclosure, considered as though metal foil were pressed into contact with accessible surfaces of insulating material.

NOTE 2 — If a barrier is interposed, the distance is measured over the barrier or, if the barrier is in two parts with mating surfaces which are not cemented together, through the joint.

---

*Specification for accessibility test probes ( *first revision* ).

**2.28 Type Test** — Tests carried out to prove conformity with the requirements of the standard. These are intended to prove the general qualities and design of a given type of tool.

**2.29 Routine Tests** — Tests carried out on each item to check the essential requirements which are likely to vary during production.

**2.30 Acceptance Tests** — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

## 3. RATING

### 3.1 Rated Voltage

**3.1.1** For tools other than extra-low voltage, the preferred rated voltage shall be 240 V for single phase and 415 V for three phase; however, 230 V and 400 V for single phase and three phase respectively are also permitted for the time being ( *see* **0.4** and **0.5** of IS : 585-1962* ). For special applications the voltage rating may be as agreed between the purchaser and the manufacturer.

**3.1.2** For extra-low voltage tools, the preferred voltages shall be 6, 12, 24 and 32 V.

**3.1.3** The preferred rated voltage for dc operated tools shall be 220 V.

**3.2 Rated Frequency** — In case of ac operated tools, the rated frequency shall be either 50, 150, 200, 300 or 400 Hz.

## 4. CLASSIFICATION

**4.1** Electric motor operated tools are classified according to the types of protections against electric shock and ingress of water as follows:

a) *Electric insulation*

   1) Class I Tools — defined in **2.14**
   2) Class II Tools — defined in **2.15**
   3) Class III Tools — defined in **2.16**

b) *Degree of protection against ingress of water* — The tools shall have one of the degrees of protection 0, 1, 4 or 7 against ingress of water in accordance with Table 2 of IS : 4691-1968†.

---

*Specification for voltages and frequency for ac transmission and distribution systems ( *revised* ).

†Degrees of protection provided by enclosures for rotating electrical machinery.

## 5. CONSTRUCTION AND MATERIALS

### 5.1 Electrical Insulation

**5.1.1** Wood, cotton, silk, paper and similar fibrous or hygroscopic material shall not used as insulation, unless effectively impregnated. Driving belt shall not be relied upon to ensure electrical insulation.

**5.1.2** Tools shall be so constructed that internal wiring, windings, commutators, slip rings, etc, and insulation in general, are not exposed to oil, grease or similar substances. Unless the construction necessitates that insulation be exposed to oil or grease as in gears and the like in which case the oil or grease shall have adequate insulating property.

**5.1.3** Tools shall be so constructed that should the conductor strands, brush shunts, screws, washers, springs and the like loosen or become free, they shall not bridge any insulation between live parts and accessible metal parts. Loosening of these parts shall not reduce clearances or creepage distances between live parts and accessible metal parts to less than 50 percent of the values specified in **18**. In case of Class II tools, should any of such parts become loose or fall out of position, it should not be disposed that creepage distances or clearances over protective insulation or reinforced insulation are reduced to less than 4 mm. Class II tools, other than those of the all insulated type shall be provided with an insulating barrier in the form of an internal enclosure or the like which enclosures the motor and all other live parts. Spring washers shall not be the sole means for prevention of the loosening of the various parts.

NOTE — Wires shall be considered as likely to become free from terminals or soldered connections, unless there is a second clamping means near the terminal or connection.

**5.1.4** Protective insulation in Class II tools shall be securely fixed in such a way that it cannot be removed without being seriously damaged or without making the tool unfit for further use. The requirement is met if the insulation is so fixed that it can be removed only by breaking or cutting.

**5.1.5** Assembly gaps in basic insulation and protective insulation shall not coincide nor shall any assembly gap in reinforced insulation give straight access from the outside of the tool in live parts.

**5.1.6** The insulation properties, mechanical strength and resistance to heat and fire of the functional insulation, including protective insulation shall be adequate througout normal use.

**5.2 Handles** — Handles, levers and the like shall be fixed in a reliable manner so that they do not work loose as a result of heating, vibration, etc, occurring in normal use.

### 5.3 Brush Gear

**5.3.0** The carbon brushes shall conform to IS : 3003 ( Part 3 )-1978* where constructional features of tool permit.

**5.3.1** It shall not be possible to gain access to brushes without the use of a tool.

**5.3.2** Screw type brush caps shall have adequate mechanical strength and shall screw home against a shoulder or similar abutment and shall engage a minimum of two full threads. Screw type brush caps which are accessible from the outside of the tool, shall be of insulating materials, or if of metal shall be covered with insulating material of adequate thickness and shall not project beyond surrounding surface of the tool.

**5.3.2.1** The brush holders which retain the brushes in position by means of locking device ( snap-on type ) shall be so designed that the locking does not depend upon the brush-spring tension if loosening of the locking device might make accessible metal parts live.

**5.3.3** Brush holders and their caps shall have adequate mechanical strength. This requirement is checked by removing and replacing the brushes ten times, the torque applied when tightening the cap with values given in Table 1.

After this test, the brush cap box and brush holder shall show no damage impairing its further use, the thread, if any, shall not be damaged and the cap shall show no cracks.

NOTE — The shape of the blade of the test screw driver shall suit the head of the screw being tested. The blade width of the test screw driver shall be as large as possible but not exceeding the length of the recess in the cap. If, however, the thread diameter is smaller than the length of the recess, the blade width shall not exceed the thread diameter. The torque shall not be applied in jerks.

**TABLE 1 VALUES OF TORQUE**

( *Clause* 5.3.3 *and* 20.5.2.2 )

| BLADE WIDTH OF TEST SCREW DRIVER | TORQUE |
|---|---|
| mm | Nm |
| Up to and including 2·8 | 0·4 |
| Over 2·8 up to and including 3·0 | 0·5 |
| Over 3·0 up to and including 4·1 | 0·6 |
| Over 4·1 up to and including 4·7 | 0·9 |
| Over 4·7 up to and including 5·3 | 1·0 |
| Over 5·3 up to and including 6·0 | 1·25 |

---

*Specification for carbon brushes for electrical machines: Part 3 Dimensions and requirements ( *first revision* ).

### 5.4 Switches

**5.4.0** Every tool shall be provided with a switch on its body suitable for frequent operation. The switch shall satisfy the requirements given in **5.4.1** to **5.4.4**.

**5.4.1** The switch shall have adequate breaking capacity. On single phase tools, except extra-low voltage tools, the switch shall disconnect both poles. On single phase Class II tools and Class III tools, the single pole switch is permitted. On three phase tools, two pole switching is permitted. Compliance is checked by the following tests.

**5.4.1.1** The switches are tested together with the tool, at 1·1 times the rated voltage or the upper ltmit of the rated voltage range of the tool. The motor is then stalled and the switch is operated 50 times, each 'ON' period having a duration of not more than 0·5 seconds and each 'OFF' period having a duration of at least 10 seconds.

**5.4.1.2** If in normal use an electronic control device switches off the current before opening the main contacts, the number of operations is reduced to 5, with the electronic control device short-circuited.

**5.4.1.3** During the test, no sustained arcing or undue burning, pitting or welding of the contacts shall occur. Also there shall be no electrical or mechanical failure within the meaning of this standard.

**5.4.2** Tools designed for use on dc only or on ac/dc shall be fitted with switches of a quick make and break type. Slow make and break switches may be fitted to tools designed for use solely on ac supply.

**5.4.3** Switches for hand-held tools shall be so located or guarded that their accidental operation is unlikely.

**5.4.4** Switches for hand-held tools shall be arranged to return automatically to the OFF position on release, except on such tools where the type and nature of work make such an arrangement undesirable, or where the continuous running of the tool is not dangerous.

**5.4.4.1** Switches with locking arrangement shall be permitted, if they unlock automatically upon operation of the switch trigger or other switch operating means.

**5.5 Change of Setting** — It shall not be possible to alter the voltage setting without the use of a tool. Tools which can be set for opposite direction of rotation shall be so constructed that any accidental changing of the setting is obvious to the user.

**5.6 Radio Interference Suppressors** — Radio and television interference suppressors, when fitted, shall be located inside the enclosure of the tool or in a strong casing firmly fixed on to the tool, unless otherwise specified.

**5.6.1** When suppressors are fixed in the flexible cord, they shall have adequate mechanical strength, be provided with suitable cord-grips and be housed in a material which is not subject to undue ageing.

**5.7 Overload Protection Devices** — Overload protection devices which are self-resetting shall not be incorporated if closure after opening an overload is likely to be dangerous to the user.

### 5.8 Internal Wiring

**5.8.1** The basic insulation of internal wiring shall be at least equivalent to the minimum insulation for flexible cords as given in IS : 9968 ( Part 1 )-1981* and IS : 694-1977†.

**5.8.2** Internal wiring and electrical connection between different parts of the tool shall be adequately protected or enclosed aqainst mechanical damage.

**5.8.3** Wireways shall be smooth and free from sharp edges, burrs, flashes, etc, which may cause abrasion of the insulation of conductors.

**5.8.3.1** Wireways shall be effectively prevented from coming into contact with moving parts.

**5.8.3.2** Holes in sheet metal through which insulated wires pass shall be provided with bushing of insulating material.

**5.8.4** Except for tools operated on extra-low voltage, any direct contact between the insulation of wiring having functional insulation only and acceesible metal parts shall be effectively prevented. Insulating sleeves may be used to prevent such contact in Class I tools provided that the conductors or sleeves are not likely to be lost during repair of the tool or replacement of the flexible cord or cable.

**5.9 Mechanical Strength** — Tools shall have adequate mechanical strength and shall pass the test specified in **20.12.**

**5.10 Protection Against Moisture** — Tools shall be so constructed that they are proof against ingress of moisture that may occur in normal use. The compliance may be checked by tests given in **20.9.**

**5.11 Resistance to Heat** — External parts and parts of insulating material supporting live parts shall be resistant to heat and shall pass the test specified in **20.16.**

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*Specification for elastomeric insulated cables: Part 1 For working voltage up to and including 1 100 V.

†Specification for PVC insulated cables for working voltage up to and including 1 100 volts ( *second revision* ).

**5.12 Resistance to Tracking** — In tools exposed to excessive deposits of moisture or dust in normal use, the insulating parts ( other than ceramic ) supporting live parts shall be of material resistant to tracking. The tool shall meet the requirements given in **20.17.1**.

## 6. COMPONENT PARTS

**6.1** Component parts, such as switches, plugs, appliances inlets, lampholders, transformers, capacitors, flexible cords and the like, shall conform to the appropriate Indian Standards so far as it reasonably applies.

The testing of component parts which have to comply with other specifications is, in general, carried out separately according to the appropriate standard under the following conditions:

a) Component parts, with individual ratings marked on them which may be used in other apparatus are tested with their marking. The number of samples tested being that required by the appropriate component specification.

It shall be ascertained that the marking of such parts suits the conditions which may occur in the tool.

b) Other components parts are tested under the conditions occurring in the tool, the number of samples tested being in general, that required by the appropriate specification.

NOTE — When the submission of additional samples of component parts is necessary, they should be submitted together with the tool in order to simplify the procedure.

c) For tools fitted with electrical or electronic speed changing switches where the speed changing is not integral with the main 'ON-OFF' function, and with reversing which is not interlocked with main 'ON-OFF' function, the switch shall be operated 25 times with the tool running under no load conditions.

During this test no sustained arcing or undue burning or welding of the contacts shall occur and there shall be no electrical or mechanical failure of the switch or of the tool.

**6.2** Plugs or appliance inlets provided with tools intended for use on voltage from 200 to 250 V shall comply with IS : 1293-1967*.

## 7. PROTECTION AGAINST ELECTRIC SHOCK

**7.1** Enclosures of tools shall have no openings other than those necessary for use and the working of the tool. Where such openings are necessary, sufficient protection shall be provided against accidental contact with live parts even after the removal of detachable parts.

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*Specification for three-pin plugs and socket-outlets ( *first revision* )

**7.1.1** Lacquer, enamel, paper cotton, and similar coverings are not deemed to provide adequate protection for the purpose of this requirements.

**7.1.2** Metal parts of double ( Class IIB ) and all-insulated ( Class IIA ) tools which are insulated from live parts by function insulation only, shall be considered to be live parts, unless functional insulation is reinforced insulation.

**7.2** Parts providing protection against accidental contact with live parts shall have adequate mechanical strength and shall not work loose in normal use. It shall not be possible to remove these parts without the use of a tool.

**7.3** Metal shafts, operating knobs, handles, levers and the like shall not be live. They shall be earthed and separated by at least functional insulation from live parts on Class I tools. They shall be separated by protective insulation from functionally insulated parts and by double-insulation or reinforced insulation from live parts on double and all-insulated Class II tools. They shall be separated by at least basic insulation from live parts on extra-low voltage Class III tools.

**7.4** Inaccessible metal parts of Class II tools shall not be in electrical contact with live parts unless this is necessary for their function.

**7.5** For Class II tools, capacitors shall not be connected to accessible metal parts and their casings, if of metal, shall be separated from accessible metal parts by supplementary insulation.

## 8. PROVISION FOR EARTHING

**8.0** The provision of **8.1** to **8.6** do not apply to Class II and Class III tools ( *see* **4.1** ).

**8.1** Accessible metal parts of Class I tools shall be in good electrical contact with each other and the tool shall be provided with permanent and reliable earthing terminal or contact as close to the supply terminals as possible. In case of tools operated at voltage in excess of 250 V, two separate earthing terminals or contacts shall be provided.

**8.2** Earthing terminals shall comply with the requirements of **16**; and their clamping screws shall be adequately locked against accidental loosening. They shall not serve to secure any other part.

**8.3** All parts of these terminals shall be such that there is no risk of corrosion resulting from contact with the copper of the earthing conductor, or any other metal that is in contact with them.

**8.3.1** The body of the terminal shall be of brass or other metal no less resistant to corrosion unless it is part of the metal frame or enclosure. The screw or nut shall be of brass or other metal no less resistant to corrosion.

**8.3.2** When the body of the earthing terminal is a part of a metal frame or enclosure made of aluminium or aluminium alloy, special precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium.

**8.4** It shall not be possible to loosen the earthing terminal screw without the use of a tool.

**8.5** Non-detachable flexible cords or cables of Class I tools shall be provided with an earthing conductor.

**8.6** The connection between the earthing terminal or earthing contact and parts required to be connected thereto, shall be of low resistance. Compliance is checked as follows:

> A high frequency inductor or step down transformer is inserted in the earthing circuit. A current derived on ac source having a no load voltage not exceeding 12 V and equal to 1·5 times rated current of the tool or 25 A, whichever is the greater is passed between the earthing terminal or earthing contact, and each of the accessible metal parts in turn. The voltage between the earthing terminal of the tool and the accessible metal part is measured, and the resistance calculated from the current and the voltage drop. In no case shall the resistance exceed 0·1 ohm.

## 9. PROTECTION AGAINST MOVING PARTS

**9.1** Moving parts shall, so far as is compatible with the use and working of the tool, be so arranged or enclosed as to provide, in normal use, adequate protection against personal injury. It shall not be possible to touch through ventilation openings dangerous moving parts. Compliance to this requirements is checked by means of standard test fingers specified in IS : 1401-1970*.

**9.1.1** Protecting enclosures, guards and the like shall have adequate machanical strength. They shall not be removable without the use of tools unless their removal is necessary in normal use.

**9.1.2** Dangerous overspeeding shall not be possible under electrical fault conditions. This does not preclude the use of suitable shunt wound motors.

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*Specification for accessibility test probes ( *first revision* ).

## 10. STABILITY

**10.1** Tools normally intended to be operated on a floor, table or similar support, which when overturned, can be a source of danger to person or to the surroundings, shall have adequate stability or provision for effectively securing them to their support. Compliance to this requirement shall be checked in accordance with **20.11**.

## 11. STARTING

**11.1** Motor shall start under all normal voltage conditions which may occur in use.

**11.1.1** Centrifugal and other automatic starting switches shall operate reliably without chattering. Compliance shall be checked in accordance with **20.4**.

**11.1.2** The unidirectional tools shall have the direction of rotation marking which shall be clearly visible from outside.

## 12. POWER INPUT AND CURRENT

**12.1** The power input at normal load at rated voltage or at the upper limit of the rated voltage range shall not exceed the rated input of the tool by more than the deviation shown below:

| *Rated Power* W | *Deviation* |
|---|---|
| Up to and including 33·3 | 10 W |
| Over 33·3 up to and including 150 | 30 percent |
| Over 150 up to and including 300 | 45 W |
| Over 300 | 15 percent |

**12.1.1** There is no lower limit to the input.

**12.2** The input current at normal load at rated voltage or at the lower limit of the rated voltage shall not exceed the rated current by more than 15 percent.

**12.3** The measured slip of induction motor of the tool shall not be more than ±50 percent of the stated slip at full load. The measured speed, in case of universal or ac/dc motor shall not be more than ±20 percent of guaranteed speed at full load.

## 13. TEMPERATURE-RISE

**13.1** The temperature-rise of the tool and the surface of its support under the normal conditions shall not exceed the values specified in Table 2, over an ambient temperature not exceeding 40°C. The contacts and other current carrying parts shall be so dimensioned that the current shall not cause excessive temperature-rise.

## TABLE 2 TEMPERATURE-RISE

( *Clauses* 13.1 *and* 20.5.2.2 )

| | TEMPERATURE-RISE °C |
|---|---|
| a) Windings: | |
| i) Insulated with Class A materials | 60 ( 50 )<br>( *see* Notes 3 and 5 ) |
| ii) Insulated with Class E materials | 75 ( 65 ) |
| iii) Insulated with Class B materials | 80 ( 70 ) |
| iv) Insulated with Class F materials | 100 |
| v) Insulated with Class H materials | 125 |
| b) Iron cores and other parts in contact with windings: | |
| i) Insulated with Class A materials | 60 |
| ii) Insulated with Class E materials | 75 |
| iii) Insulated with Class B materials | 80 |
| iv) Insulated with Class F materials | 100 |
| c) Externals enclosure, except handles held in normal use | 45 |
| d) Handles, knobs, grips and the like which, in normal use, are continuously held: | |
| i) Of metal | 15 |
| ii) Of porcelain or vitreous material | 25 |
| iii) Of moulded materials, rubber or wood | 35 |
| e) Outer surface of capacitors: | |
| i) With marking of maximum operating temperature ( $t_c$ ) | $t_c$-50 |
| ii) Without marking of maximum operating temperature: | |
| Small ceramic capacitors for radio and television interference suppression | 35 |
| Other capacitors | 5 |
| f) Rubber or polyvinyl chloride insulation of internal and external wiring and flexible cords: | |
| if no flexing occurs or is likely | 35 |
| g) Rubber used for parts, the deterioration of which could affect safety: | |
| When used as protective insulation or as reinforced insulation | 25 |
| In other cases | 35 |

( *Continued* )

**TABLE 2 TEMPERATURE-RISE** — *Contd*

( *Clauses* 13.1 *and* 20.5.2.2 )

| | TEMPERATURE-RISE °C |
|---|---|
| h) Material used as insulation other than for wires and windings: | |
| Impregnated or varnished textile, paper or press board | 55 |
| Laminates bonded with: | |
| Melamine-formaldehyde, phenol-formaldehyde or phenol furfural resins | 70 ( 160 )<br>( *see* Note 4 ) |
| Urea formaldehyde resin | 50 ( 135 ) |
| Moulding of: | |
| phenol-formaldehyde with cellulose fillers | 70 ( 160 ) |
| phenol-formaldehyde with mineral fillers | 85 ( 185 ) |
| melamine-formaldehyde | 60 ( 135 ) |
| Urea formaldehyde | 50 ( 135 ) |
| Thermoplastic materials: | |
| Polyester with glass fibre reinforcement | 95 |
| Silicone rubber | 130 |
| ( There is no specific limit for thermoplastic material which must withstand the tests of **20.16** for which purpose the temperature-rise shall be determined. ) | |
| Wood | 45 |
| j) Parts in contact with oil having a flash point of $T$°C | $T$°—65 |

NOTE 1 — If other materials are used, they shall not be exposed to temperature in excess of those which have been provided permissible for the material concerned.

NOTE 2 — For special grades of these materials higher temperatures are permissible.

NOTE 3 — The values of temperature-rise of windings of motors, relays, solenoids given without brackets apply when the resistance method is used and those within brackets apply when thermocouples/thermometers are used.

NOTE 4 — The values within brackets apply, if the material is used for handles, knobs, grips and the like and is in contact with hot metal.

NOTE 5 — The classification of insulating materials is covered in IS : 1271-1958 'Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service'.

## 14. ABNORMAL OPERATION

**14.1** Tools shall be so designed that risk of fire, mechanical damage or electric shock as a result of abnormal or careless operation is limited as far as possible.

**14.2** Tools incorporating electronic devices shall be so designed that, in the event of a failure, the speed does not increase to such an extent that this might result in a hazard.

**14.3** Switches or other devices for reversing the motor, shall withstand stresses occurring when the direction of rotation is reversed under running conditions, if such a change is possible in normal use.

## 15. SUPPLY CONNECTION

**15.1** Unless otherwise specified, the length of the non-detachable sheathed flexible cable or cord of the hand held tools shall be 2 metres.

**15.1.1** *Colour Identification* — Three core insulated and sheathed cables, with the cores coloured green, black, and red shall be used for supply connections for Class I tools green being connected to earth, black to neutral and red to live terminals respectively. Class II tools shall be provided with 2 core insulated and sheathed, cables, the cores being red and black in colour.

**15.2** Sheathed flexible cables shall conform to IS : 9968 ( Part 1 )-1981* or IS : 694-1977†. The flexible cord or cable shall be of sufficient current carrying capacity with reference to the rated loading of the tool. the cross-sectional area of conductor and number of wires of the cable shall comply with Table 3.

**TABLE 3 CROSS-SECTIONAL AREA OF CORDS/CABLES**

( *Clauses* 15.2, 15.4.3, 16.2 *and* 16.5 )

| RATED CURRENT OF TOOL | NOMINAL CROSS-SECTIONAL AREA | NUMBER AND DIAMETER OF WIRES IN mm |
|---|---|---|
| (1) | (2) | (3) |
| A | mm$^2$ | mm$^2$ |
| Up to and including 3 | 0·5 | 16/0·20 |
| Over 3 and up to and including 6 | 0·75<br>(1) | 24/0·20<br>(32/0·20) |
| Over 6 and up to and including 10 | 1 | 32/0·20 |
| Over 10 and up to and including 16 | 1·5 | 48/0·20 |
| Over 16 and up to and including 25 | 2·5 | 80/0·20 |

NOTE — The value in bracket applies to tools having a mass exceeding 2·5 kg.

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*Specification for elastomeric insulated cables: Part 1 For working voltages up to and including 1 100 V.

†Specification for PVC insulated cables for voltages up to and including 1 100 V ( *second revision* ).

**15.3** The space for the supply conductors and the earth conductor, if any, shall be adequate to allow the conductors to be easily introduced and connected, and the cover fitted without risk of damage to the conductors or their insulation. It shall be possible to check that the conductors are correctly connected and positioned before the cover is fitted.

### 15.4 Cord Grip

**15.4.1** Tools shall be provided with a cord grip so that the conductor are relieved from strain, including twisting, where they are connected to the terminals and their outer covering shall be protected from abrasion. It shall be clear how the relief from strain and the prevention of twisting is intended to be affected. Make shift methods such as tying the cable into a knot or tying the ends with string shall not be used.

**15.4.2** At least one part of the cord grip shall be securely fixed to the tool.

**15.4.3** The surface by which the cord is gripped and any parts with which the cord might come in contact shall be of insulating material or be covered with insulating material if a fault in the insulation of the cord could make accessible live parts. The cord grip shall be capable of effectively clamping the flexible cord appropriate to the current rating specified in Table 3 and the largest cord which may be introduced through the cord guard.

**15.4.4** Cord grips shall be so designed that the cord may not come into contact with the cord grip screws, if these are accessible or are electrically connected to accessible metal parts.

**15.4.5** For class I tools the cord grip shall be either of insulating material or be provided with an insulating lining secured in such a way that it shall not become loose during normal operation. The flexible cord guard specified in **15.5** is considered an adequate lining for the cord grip.

**15.4.6** The cord grip for Class II tools shall be of insulating material or, if wholly or any part of metal, which is accessible, such metal parts shall be insulated from the sheath of the flexible cord and from accessible metal parts by insulation complying with the requirements for protective insulation. The sheath of the flexible cord is deemed not to be protective insulation.

### 15.5 Cord Guards

**15.5.1** Flexible cable shall be protected against excessive bending at the inlet openings of the tool by means of cord guard of insulating materials. Such guards shall not be integral with the flexible cable and shall be fixed in such a manner that they shall not become loose during normal operation. Cord guards shall project beyond the inlet opening for at least 25 mm or 5 times the diameter of cord whichever is higher.

**15.5.2** Cord guards shall have adequate mechanical strength and flexibility and shall retain these properties throughout the normal life of the tool.

**15.5.3** Inlet openings shall be so formed that the cord guard is not exposed to bending over sharp edges.

## 16. TERMINALS FOR CONNECTION OF FLEXIBLE CORDS

**16.1** Tools having a rated input exceeding 100 W and intended to be connected by means of a nondetachable flexible cable or cord shall be provided with terminals to which the cord can be connected by means of screw, nuts, or other equally effective devices.

**16.1.1** Tools having a rated input not exceeding 100 W shall be provided with terminals in which connection is made by means of screws, nuts or other equally effective devices, or termination for soldering.

**16.1.2** Terminal screws and nuts shall not serve to fix any other component. The means for connecting the supply conductor shall not be used for the connection of any other conductor.

**16.2** Terminals and terminations shall allow the connection of conductors having nominal cross-sectional area in accordance with Table 3 appropriate to the rating of the tool.

**16.3** Terminals shall be fixed in such a way that they will not work loose when the clamping means is tightened or loosened. Cover with sealing compound without other means of locking is deemed not to be sufficient.

**16.4** Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor.

**16.5** Terminals shall be so arranged that the conductors do not slip out when the screws or nuts are tightened and they shall not require special preparation of the conductor ( for example, soldering of the strands, use of cable lugs, formation of eyelets, etc ) in order to meet this requirement. Terminal screws shall engage, when correctly tightened with the conductors having sectional area in accordance with Table 3 appropriate to the rating of the tool, for at least two full threads of the screw.

**16.6** In pillar terminals and other terminals of the pinch screw type, the length of the threaded part of the terminal screw shall be not less than the sum of the diameter of the hole provided for the conductor and the length of the thread in the block. The diameter of the hole shall be not more than 0·6 mm larger than the diameter of the screw for terminals for rated current up to and including 15 A and 1 mm for terminals for higher currents. The ends of the screw shall be rounded or chamfered to prevent damage to the conductors; the inside of the hole shall be smooth and continuous.

**16.6.1** Pillar terminals shall be so designed and located that the end of a conductor introduced into the hole provided for the conductor is visible or can pass beyond the threaded hole for a distance at least equal to 2·5 mm.

**16.7** Soldered terminations shall be so designed that they keep the conductor in position if the conductor breaks at the point of connection.

**16.8** Terminals and terminations shall not be accessible without the aid of a tool.

**16.8.1** Terminals and terminations shall be so located or shielded that should strand of a conductor escape from a terminal when the supply conductors are fitted, there is not risk of accidental contact between live parts of different polarity or between such parts and other metal parts.

**16.9** Where terminals are provided for the connection of flexible cables or cords, each terminal shall be located in proximity to its corresponding terminals of different polarity and to the earthing terminals.

## 17. SCREWS AND CONNECTIONS

**17.1** Screwed connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use.

**17.1.1** Screws transmitting electrical contact pressure and screws with a nominal diameter less than 4 mm, which are likely to be operated by the user, shall screw into a metal nut or metal insert. This requirement is not applicable to brush holders or brush holder caps.

**17.1.2** Screws shall not be of a metal which is soft or liable to creep, such as zinc or aluminium.

**17.2** Screws in engagement with a thread of insulating material and which transmit electrical contact pressure or are likely to be operated by the user shall have a thread length not less than 3 mm plus one-third of the nominal screw diameter except that this length need not exceed 8 mm. Where the nominal diameter of the thread exceed 6 mm diameter, the length need not exceed 3 full threads.

**17.2.1** Correct introduction of such screws into their counterparts shall be ensured.

**17.3** Electrical connection shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, mica or other materials not liable to shrinkage or deterioration unless possible shrinkage of the insulating material is compensated by ample resilience in metallic parts.

**17.4** Screws and rivets which serve as electrical and as well as mechanical connections shall be locked against loosening.

**17.5** Electrical connections which are subject to severe vibration in normal use, shall be secured in such a way that they do not work loose during the operation of the tool.

## 18. CREEPAGE DISTANCES, CLEARANCES AND DISTANCES THROUGH INSULATION

**18.1** Creepage distances clearance and distances through insulation shall be not less than the value given in Table 4 and Table 5 respectively.

## 19. MARKING

**19.1** Tools manufactured in compliance with this standard shall be marked, clearly and indeliby with the following:

a) Reference to this Indian Standard, for example, Ref ISS 4665-1984;
b) Manufacturer's name or trade-mark;
c) Manufacturer's model or type reference;
d) Rated voltage or voltage range in volts;
e) Nature of supply;
f) Rated frequency;
g) Rated input in watts;
h) Rated current in amperes;
j) Rated operating and resting time in hours, minutes or seconds, if to be observed;
k) Degree of protection against ingress of water;
m) Tools intended for either delta or star connection shall be clearly marked with two rated voltages ( for example, 415 and 240 );
n) No load speed;
p) Country of origin, and
q) Symbol for Class II construction, if applicable.

**19.1.1** All-insulated and double-insulated tools shall be clearly marked 'DO NOT EARTH — ALL-INSULATED' or 'DO NOT EARTH — DOUBLE-INSULATED'.

**19.2** If the tool can be set to different rated voltages, the voltage to which the tool is set shall be clearly discernible.

## TABLE 4 CREEPAGE DISTANCES

( *Clause* 18.1 )

| PART<br>(1) | CLASS III TOOLS<br>(2)<br>mm | CLASS I AND CLASS II TOOLS<br>(3)<br>mm |
|---|---|---|
| i) Between live parts of different polarity: | | |
| a) If protected against deposition of dirt | 2 | 2-2-3<br>( *see* Note 1 ) |
| b) If not protected against deposition of dirt | 2 | 3-4-5<br>( *see* Note 1 ) |
| ii) Between live parts and other metal parts: | | |
| a) Over functional insulation protected against deposition of dirt: | | |
| If of ceramic material, pure mica and the like | 2 | 2-3<br>( *see* Note 2 ) |
| If of other material | 2 | 3 |
| b) Over functional insulation not protected against deposition of dirt | 2 | 4 |
| Over reinforced insulation | — | 8 |
| iii) Between metal parts separated by protective insulation | — | 4 |
| iv) Between lacquered or enamelled windings and metal parts separated from live parts: | — | — |
| a) By functional insulation only | 2 | 2 |
| b) By reinforced insulation | — | 6 |
| v) Between windings having functional insulation and accessible metal parts of class II tools ( *see* Note 3 ) | — | 4 |

NOTE 1 — The first value applies to tools having a rated voltage not exceeding 250 V, the second to tools having a rated voltage exceeding 250 V, but not exceeding 300 V, and the third to tools having a rated voltage exceeding 300 V.

NOTE 2 — The first value applies only if the parts are rigid and located by mouldings, or if the design is otherwise such that there is no likelihood of a distance being reduced by distortion or movement of the parts. If this is the case, the second value applies.

NOTE 3 — Windings are considered to have functional insulation if they are wrapped with tape and then impregnated, or if they are covered with a layer of self-hardening resin, and if, after the test of **20.9**, a high voltage test as specified in **20.7** is withstood, the test voltage being applied between the conductors of the winding and metal foil in contact with the surface of the insulation.

It is sufficient that the wrapping and impregnation, or the layer of self-hardening resin, cover the windings only at places where it is not possible to obtain the creepage distances or clearances specified.

NOTE 4 — The creepage distance is not applicable to the insulation of internal wiring and of external flexible cables and cords.

## TABLE 5 CLEARANCE AND DISTANCES THROUGH INSULATIONS

( *Clause* 18.1 )

| PART | CLASS III TOOLS | CLASS I AND CLASS II TOOLS |
|---|---|---|
| (1) | (2) | (3) |
| | mm | mm |
| i) Between live parts of different polarity: | | |
| a) If protected against deposition of dirt | 2 | 2- 2- 3<br>( *see* Note 1 ) |
| b) If not protected against deposition of dirt | 2 | 3- 3- 4<br>( *see* Note 1 ) |
| ii) Between live parts and other metal parts: | | |
| a) Separated by functional insulation: | | |
| If protected against deposition of dirt | 2 | 2- 3<br>( *see* Note 2 ) |
| If not protected against deposition of dirt | 2 | 3 |
| b) Separated by reinforced insulation | — | 8 |
| iii) Between metal parts separated by protective insulation | — | 4 |
| iv) Between lacquered or enamelled windings and metal parts separated from live parts: | | |
| a) By functional insulation only | 2 | 2 |
| b) By reinforced insulation | — | 6 |
| v) Between windings having functional insulation and accessible metal parts of class II tools ( *see* Note 3 ) | — | 4 |
| vi) Distance through insulation between metal parts ( *see* Note 4 ) | | |
| a) Separated by protective insulation | — | 1 |
| b) Separated by reinforced insulation | — | 2 |

NOTE 1 — The first value applies to tools having a rated voltage not exceeding 250 V, the second to tools having a rated voltage exceeding 250 V, but not exceeding 300 V, and the third to tools having a rated voltage exceding 300 V.

NOTE 2 — The first value applies only if the parts are rigid and located by mouldings, or if the design is otherwise such that there is no likelihood of a distance being reduced by distortion or movement of the parts. If this is not the case, the second value applies.

NOTE 3 — Windings are considered to have functional insulation if they are wrapped with tapes and then impregnated, or if they are covered with a layer of self-hardening resin, and if, after the test of **20.9**, a high voltage test as specified in **20.7** is withstood, the test voltage being applied between the conductors of the winding and metal foil in contact with the surface of the insulation.

It is sufficient that the wrapping and impregnation, or the layer of self-hardening resin, cover the windings only at places where it is not possible to obtain the creepage distances or clearances specified.

NOTE 4 — The clearance distance is not applicable to the insulation of internal wiring and of external flexible cables and cords.

**19.3** If the tool is marked with a rated voltage range, the marking of rated inputs shall relate to the upper limit of the range and the rated current to the lower limit. The speed should correspond to the mean of the voltage range.

**19.4** Tools designed for intermittent operation and if not specified in the particular specification, shall be marked with the rated operating time and resting time, unless the time of operation is limited by construction.

**19.5** When symbols are used, they shall be as follow:

| | |
|---|---|
| Volts | V |
| Amperes | A |
| Hertz or cycles per second | Hz |
| Watts | W |
| Kilowatts | kW |
| Hours | h |
| Minutes | min |
| Seconds | s |
| Revolutions or reciprocations per minute | /min |
| Alternative current | ~ |
| ac/dc | ≃ |
| Three-phase alternating current | 3 ~ |
| Three-phase alternating current with neutral | 3N ~ |
| Direct current | — |
| Class II construction | ⧈ |
| Drip-proof construction ( one drop ) | 💧 |
| Splash-proof construction ( one drop in triangle ) | ⚠ |
| Watertight construction ( two drops ) | 💧💧 |

**19.6** Earthing terminal shall be indicated by the symbol ⏚. This symbol shall not be placed on screws, removable washers, or similar removable parts.

**19.7** Tools to be connected to more than two supply conductors shall be provided with a wiring diagram, unless the correct mode of connection is obvious.

**19.7.1** For tools with star-delta connection the wiring diagram shall also show how the winding shall be connected.

**19.8** The tools may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act, and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## 20. TESTS

### 20.1 Conditions for Tests

**20.1.1** Unless otherwise specified, the tests are made on a single sample as drawn which shall withstand all the relevant tests.

**20.1.2** Unless otherwise specified in the relevant test clause or in the individual specification ( *see* Part 2 ) general conditions for test specified in **20.1.3** to **20.1.11** below shall apply.

**20.1.3** Unless otherwise specified, the test shall be carried out at the rated frequency, at any ambient temperature not higher than 40°C, and the tool being placed in the most unfavourable position of normal use.

**20.1.4** When the conditions of normal load are specified in the relevant specification, the tool is loaded according to these conditions irrespective of any marking of short-time operation or intermittent operation, unless it is evident from the design of the tool that these conditions will not occur in normal use.

**20.1.5** When loads are to be applied the method of loading shall be such that no additional stresses, such as side thrust, are imposed.

**20.1.6** Tools marked as suitable for ac only shall be tested with ac and those for dc only with dc.

**20.1.7** Tools designed for more than one rated voltage, or for both ac and dc be tested under the conditions related to the most unfavourable voltage and nature of supply.

**20.1.8** Tools provided with regulating or limiting devices shall be tested with those devices set to their most unfavourable position, unless otherwise specified in the relevant specification.

**20.1.9** Tools designed for use with non-detachable flexible cable shall be tested with the flexible cable supplied with tool unless the cable length exceeds 4 m in which case the tests shall be conducted after removing the cable.

**20.1.10** Wherever tests are not specified, compliance to the specification requirements are checked by visual inspection.

**20.1.11** In the case of electronic speed controller fitted tools, the tests shall be done at the highest speed setting.

### 20.2 Classification of Tests

**20.2.1** *Type Tests* — The following shall be carried out as type tests preferably in the following sequence:

a) Protection against electric shock ( **20.3** );
b) High voltage ( **20.7** );
c) Starting ( **20.4** );
d) Input and current ( **12** );
e) Temperature-rise ( **20.5** );
f) Leakage current ( **20.6** );
g) Insulation resistance ( dry ) ( **20.8** );
h) Moisture resistance ( **20.9** );
j) Endurance ( **20.10** );
k) Stability ( **20.11** );
m) Mechanical strength ( **20.12** );
n) Abnormal operation ( **20.13** );
p) Supply connections ( **20.14** );
q) Screws and connections ( **20.15** );
r) Resistance to heat ( **20.16** );
s) Resistance to tracking ( **20.17** );
t) Resistance to rusting ( **20.18** ); and
u) Constructional requirements ( **5** and **6** ).

**20.2.2** *Acceptance Test* — Unless otherwise specified in the individual specification ( *see* Part 2 ) acceptance tests as follows shall be carried out on samples of completed tools. The acceptance tests shall be subject to the agreement between the manufacturer and the user:

a) Temperature-rise ( **20.5** );
b) High voltage ( **20.7** );
c) Insulation resistance ( **20.8** );
d) Leakage current( **20.6** ); and
e) Endurance ( **20.10** ).

**20.2.2.1** A recommended sampling procedure for acceptance tests and criterion for conformity is specified in Appendix A.

**20.2.3** *Routine Test* — Unless otherwise specified in the individual specification routine test as follows shall be carried out on all completed tools:

The tool shall be run on no load at rated voltage or at the mean of the voltage range for at least 20 cycles of 100 seconds: ON and 20 seconds OFF. An ac voltage as specified below shall then be applied for 1 second between live parts and body of the tool. The test is carried out at normal room temperature:

| | | |
|---|---|---|
| Class I | Tools | 1 500 volts |
| Class II | Tools | 4 000 volts |
| Class III | Tools | 500 volts |

No flashover or breakdown of insulation shall occur.

### 20.3 Protection Against Electric Shock

**20.3.1** For the purpose of determining whether live parts or metal parts are likely to become live or exposed to inadvertant personal contact ( *see* **7** ), a test finger shall be used as described in Fig. 1 of IS : 1401-1970*.

**20.3.1.1** In additon, apertures in class II and class I tools, other than those in metal parts connected to an earthing terminal or earthing contact and those giving access to lamp caps or live parts in socket outlets, are tested with the test pin shown in Fig. 3 of IS : 1401-1970*.

**20.3.1.2** After removal of detachable parts, the test finger and the test pin are applied in every possible position, the test finger being applied without appreciable force and the test pin with a force of 10 N. Apertures which prevent the entry of the test finger are further tested by means of a straight unjointed test finger of the dimensions given in Fig. 2 of IS : 1401-1970*. Which is applied with a force of 50 N, if this finger enters, the test with the test finger is repeated, except that the force necessary to push the finger through the aperture is exerted. An electrical contact indicator is used to show contact.

**20.3.2** It shall not be possible to touch bare live parts or live parts protected by lacquer, enamel, paper, cotton, oxide film, beads, sealing compound or similar coverings only, with the test finger or, for class II tools, with the test pin.

For class II tools, it shall not be possible to touch metal parts separated from live parts by functional insulation only, with the test finger.

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*Specification for accessibility test probes ( *first revision* ).

**20.3.3** Tools intended to be connected to the supply by means of a plug shall be so designed that in normal use there is no risk of electric shock from charged capacitors when touching the pins of the plug.

**20.3.3.1** The compliance is checked by the following test which is made 10 times:

> The tool is operated at rated voltage or at the upper limit of the rated voltage range. The main switch, if any, is then moved to the 'OFF' position and the tool is disconnected from the supply by means of the plug. One second after disconnection, the voltage between the pins of the plug shall not exceed 30 V.

NOTE — Capictors having a rated capacitance not exceeding 0·1 μF are not considered to entail a risk of electric shock.

### 20.4 Starting

**20.4.1** Unless otherwise, specified in Part 2 of this standard, the tool with no load applied shall not fail to start when connected to a supply at 0·85 times the rated voltage or 0·85 times the lower limit of the rated voltage range; regulating devices, if any, being set as in normal use.

**20.4.1.1** The test is made 10 times.

**20.4.1.2** The above test is repeated on tools provided with a centrifugal or other automatic starting switch at 1·10 times, the rated voltage or 1·10 times, the upper limit of the rated voltage range.

### 20.5 Temperature-Rise Test

**20.5.1** *Connection to the Supply* — Unless otherwise specified in Part 2 of this standard, the tools are operated under normal load or under the load necessary to attain the rated input whichever is the higher the tool being connected to the most unfavourable voltage between 0·90 and 1·10 times the rated voltage, or between 0·90 times the lower limit and 1·10 times the upper limit of the voltage range. The temperatures are measured as follows:

a) For tools marked on the nameplate for intermittent operation, when the maximum values are attained under the intermittent load conditions specified on the nameplate, unless conditions of normal load are specified in the individual specification; and

b) For all other tools, when the steady temperature is attained, tools designed to be placed on a floor, table or similar support in normal use shall be tested on a dull black painted wooden support.

**20.5.2** *Measurement of Temperature* — Winding temperature shall be determined by the resistance method. Other temperatures shall be determined by means of thermocouples, thermometers or thermisters so chosen and positioned that they have the minimum effect on the temperature of the part under test.

Thermocouples for determining the temperature of the wooden supporting surface shall be attached to the underside of small dull blackened sheets of copper or brass, which shall be flush with the surface.

**20.5.2.1** Sealing compound if any, shall not flow out during the test.

**20.5.2.2** Temperature-rise shall not exceed the values specified in Table 2.

NOTE — The value of the temperature-rise of a copper winding is calculated from the following equation:

$$\Delta t = \frac{R_2 - R_1}{R_1} ( 235 + t_1 ) - ( t_2 - t_1 )$$

where

$\Delta t$ = temperature-rise,
$R_2$ = resistance at the end of the test,
$R_1$ = resistance at the beginning of the test,
$t_1$ = ambient temperature at the beginning of the test, and
$t_2$ = ambient temperature at the end of the test.

It is recommended that the resistance of windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time may be plotted for ascertaining the resistance at the instant of switching off.

**20.5.2.3** If the temperature rise of a winding or core lamination exceeds the value specified in **13.1**, three additional samples are subjected to the following tests:

1. The temperature rise of the windings and core laminations is determined by the method given in **20.5.1** and **20.5.2**.
2. The samples are then dismantled as far as possible without damaging any part. Windings and core laminations are kept for 10 days ( 240 h ) in a heating cabinet, the temperature of which is 80 ± 1°C in excess of the temperature-rise determined according to item 1.
3. After this treatment, the samples are reassembled and no interturn short-circuit shall occur.

   Interturn short-circuits may be detected by means of a winding tester.
4. Immediately afterwards, the samples shall withstand the tests of **20.7** and **20.8**.
5. The samples are then subjected to a humidity treatment as specified in **20.9**.

After this treatment, they shall again withstand the tests given in **20.7** and **20.8**.

Tools are considered not to comply with the requirements of **13.1**, if there are more failures than that of one sample in one of the tests of items 3 to 5. If one sample fails in a test, the tests of items 1 to 5 are repeated on another set of 3 samples, all of which shall then comply with the repeated tests.

### 20.6 Leakage Current

**20.6.1** *To be Measured when Steady Temperatures are Attained* — The leakage current between live parts and external metal parts or a metal foil placed on external insulating parts shall be measured when the tool has been operated under normal load, the tools being connected to 1·10 times the rated voltage or 1·10 times the upper limit of the voltage range, and/or until stable temperature on insulation and other component parts have been reached.

**20.6.2** *Circuit Arrangement*

**20.6.2.1** The test shall be made with ac except in the case of tools for dc only, when dc is used.

**20.6.2.2** The tools shall be well insulated from earth. Normal earthing connections shall not be made and it shall rest on a base well insulated from earth. It is recommended that it should be supplied through an isolating transformer. Any interference suppression device fitted to the tools shall be disconnected.

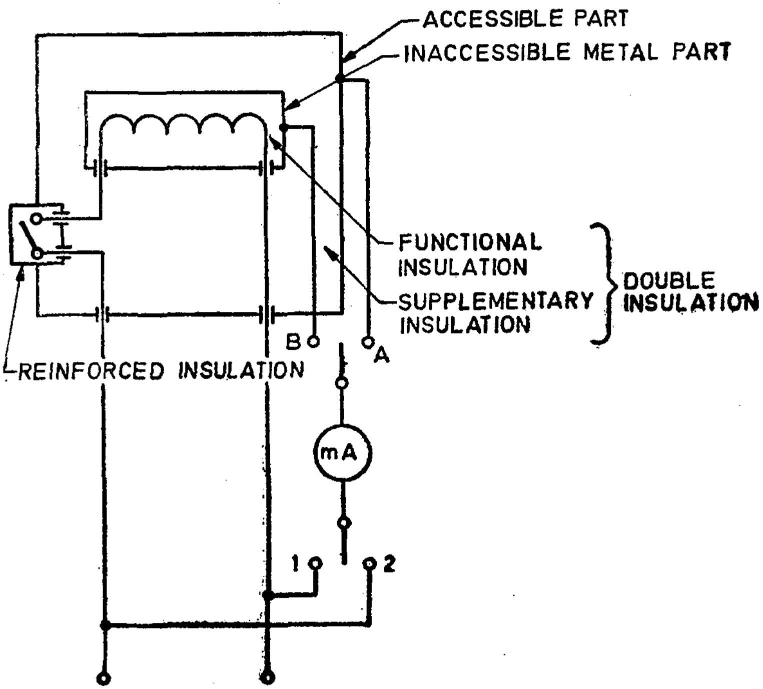
**20.6.2.3** A single-pole changeover switch shall be arranged as shown in the circuit of Fig. 1 to connect a multirange milliammeter between frame and each live part of the tools in turn. The resistance of the measuring circuit shall be 2 000 ± 100 ohms. The milliammeter used to measure the leakage current should have an impedance small in comparison with that of the circuit under test and be of a type not appreciable affected by current wave-forms.

NOTE — To avoid risk to the milliammeter a suitable high resistance with a shunting switch may be used in series with the meter. The shunting switch should be kept open to start with and when it is ensured that the meter is safe in both the positions of the changeover switch, the shunting switch shall be closed and readings taken.

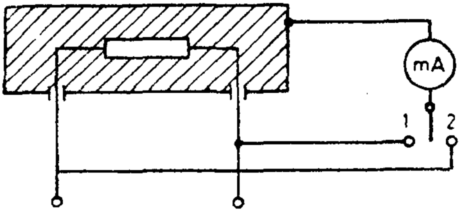
**20.6.3** The leakage current shall be measured with the milliammeter connected alternatively to line 1 and line 2.

**20.6.3.1** The leakage current shall not exceed the values shown in Table 6.

The cut off frequency of 5 000 Hz may, for example, be obtained by connecting a capacitor of 150 ± 7·5 nF in parallel with the resistive



1A Circuit Diagram for Leakage Current in Class II Tools



1B Circuit Diagram for Leakage Current in Other Tools

Fig. 1 Circuit Diagram for Leakage Current Measuraments

components of the measuring circuit. The measuring circuit may be partly or completely incorporated in the measuring. If an instrument of the rectifier type is used, it shall rectify linearly from 50 μA upwards within the frequency range of 20 to 10 000 Hz, and shall be calibrated in rms values with a current of substantially sine-wave form. If high frequency voltages are not present, the cut off frequency of the measuring instrument may exceed 5 000 Hz. For tools with heating elements incorporated the total leakage current shall be within the limits shown in Table 6.

TABLE 6 LEAKAGE CURRENT

( *Clause* 20.6.3.1 )

| SL No. | PART | CLASS III TOOLS | CLASS II TOOLS | CLASS I TOOLS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| i) | Between any pole of the supply and accessible metal parts and metal foil with an area not exceeding 20 cm × 10 cm in contact with accessible surfaces of insulating material, connected together | 60 $\mu$A ( peak ) | 60 $\mu$A ( peak ) | 300 $\mu$A ( peak ) |
| ii) | Inaccessible metal parts separated from live parts by functional insulation only | — | 300 $\mu$A ( peak ) | — |

## 20.7 High Voltage

**20.7.1** The tool shall be connected to the rated supply and operated under normal load or as in normal use for a period of at least 10 minutes.

**20.7.2** An ac high voltage of value specified in Table 7 shall be applied between the specified parts for a period of 1 minute.

TABLE 7 TEST VOLTAGES

( *Clause* 20.7.2 )

| INSULATION TO BE TESTED | TEST VOLTAGE |
|---|---|
| 1. Class I Tools: | V |
| a) Between live parts of different polarity | 1 500 |
| b) Between live parts and the body | 1 500 |
| c) Between the body and metal foil in contact with the inner surface of the insulating barriers | 1 500 |
| d) Between the conductors and metal foil in contact with the outer surface of the insulation of internal wiring which is required to be provided with sleeves or the like | 1 500 |
| e) Between the inner and outer surfaces of sleeves or the like internal wiring | 1 500 |
| f) Between internal wiring and metal foil in contact with the outer surface of non-removable sleeves of such wiring | 8 000 |

( *Continued* )

### TABLE 7 TEST VOLTAGES — *Contd*

( *Clause* 20.7.2 )

| INSULATION TO BE TESTED | TEST VOLTAGE |
|---|---|
| 2. Class II Tools: | |
| a) Between live parts of different polarity | 1 500 |
| b) Between live parts and other inaccessible metal parts | 1 500 |
| c) Between the conductors and metal foil in contact with the outer surface of the functional insulation of internal wiring | 1 500 |
| d) Between inaccessible metal parts and the body | 2 500 |
| e) Between the body and metal foil in contact with the inner surface of insulating barriers | 2 500 |
| f) Between the body and either metal foil wrapped round the supply flexible cable or cord inside inlet bushings, cord guards, cord anchorages and the like, or a metal rod of the the same diameter as the flexible cable or cord inserted to in its place | 2 500 |
| g) Between live parts and parts of the body that are separated from live parts by reinforced insulation | 4 000 |
| 3. Class III Tools: | |
| a) Between live parts of different polarity | 500 |
| b) Between live parts and the body | 500 |

NOTE — The test between live parts of different polarity is only made where the necessary disconnections can be made without damaging the tool, for example, between the contact members of the mains switch in the OFF position. The test is not made between the contacts of switches of micro gap construction, thermal cut-outs and the like, or on the insulation of capacitors connected between live parts of different polarity.

**20.7.2.1** The test voltage shall be of approximately sine-wave form having a frequency between 40 and 60 Hz.

**20.7.3** Initially, not more than 50 percent of the full test voltage is applied, then it is raised uniformly to the full value within 30 seconds.

**20.7.4** No flashover or breakdown shall occur during the test.

**20.7.5** *Test Equipment*

**20.7.5.1** The high voltage transformer used for the test shall be so designed that when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

**20.7.5.2** The overcurrent relay shall not trip when the output current is less than 100 mA.

**20.7.5.3** Care is taken that the rms value of the test voltage applied is measured within ±3 percent and that the metal foil is so placed that no flashover occurs at the edges of the insulation.

**20.8 Insulation Resistance Test** — The insulation resistance tests shall be measured at ambient temperature on the completed tool and after the moisture proofness tests.

**20.8.1** The insulation resistance shall be measured with a dc voltage of approximately 500 V. The measurement being made 1 minute after the application of the voltage. The insulation resistance shall be not less than shown in Table 8.

NOTE — The term 'body' has been defined in **2.20**.

### TABLE 8 INSULATION RESISTANCE

( *Clause* 20.8.1 )

| | INSULATION TO BE TESTED | INSULATION RESISTANCE<br>megohm |
|---|---|---|
| i) | Between live parts and the body: | |
| | a) For functional insulation | 10 |
| | b) For reinforced insulation | 20 |
| ii) | Between live parts and metal parts of class II tools which are separated from live parts by functional insulation only | 10 |
| iii) | Between metal parts of Class II tools which are separated from live parts by functional insulation only, and the body | 20 |

## 20.9 Protection Against Moisture and Ingress of Water

**20.9.1** *Test for Degree of Protection Against Ingress of Water* — The tool shall be tested for protection against ingress of water for the degree of protection provided by the enclosures in accordance with IS : 4691-1968*.

**20.9.2** *Humidity Test* — The tool shall be subjected to the humidity treatment described below, followed immediately by the measurement of the insulation resistance and by the high voltage test. The insulation resistance measured shall be not less than 2·0 megohms.

**20.9.2.1** Covers and other component parts, which may be removed without the use of tools shall be removed and subjected, if necessary, to the humidity treatment with the main part.

**20.9.2.2** The humidity treatment is carried out in a humidity cabinet containing air with relative humidity maintained not less than 95 percent at a temperature of 27 ± 2°C.

Before being placed in the humidity cabinet, the sample is brought to the specified temperature of 27 ± 2°C, by keeping the sample in the cabinet for:

a) 2 days ( 48 hours ) for tools having '0' degree protection ( *see* IS : 4691-1968* ) against ingress of water, and

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*Degrees of protection provided by enclosures of rotating electrical machines.

b) 7 days ( 168 hours ) for tools having protection against ingress of water of a degree other than '0'.

**20.9.2.3** In most cases the samples may be brought to the specified temperature of 27 ± 2°C by keeping them at this temperature for at least four hours before the humidity treatment.

### 20.10 Endurance Test

**20.10.1** The tool is operated intermittently with no load, for 24 hours, at 1·1 times the rated voltage or at 1·1 times the upper limit of the rated voltage range, and for 24 hours at 0·9 times the rated voltage or 0·9 times the lower limit of the rated voltage range, unless otherwise specified. Each cycle of operation comprises an ON period of 100 seconds and an OFF period of 20 seconds, the OFF periods being included in the specified operating time.

NOTE — The endurance test with load on the tool is under consideration.

**20.10.1.1** If change of position is likely to occur in normal use, the tool is placed in at least three different positions during the test, the required operating time at each test voltage being approximately equally divided among the different positions.

The change of position is made to prevent abnormal accumulation of carbon dust in any particular place. In general, for hand-held tools the three positions are horizontal, vertically up and vertically down. Changing the position of the tool is, therefore, not necessary on brushless motor type tools.

**20.10.1.2** During the test, brushes should be inspected and replaced when necessary by spare brushes supplied by the manufacturer.

**20.10.1.3** The tool may be switched ON and OFF by means of a switch other than that incorporated in the tool.

**20.10.1.4** If the temperature-rise of any part of the tool exceeds the temperature-rise measured during the temperature-rise test, rest periods or artificial cooling are introduced, such rest periods being excluded from the operating time specified.

**20.10.2** Tools provided with a centrifugal or other automatic starting switch, shall be started 1 000 times with no load unless otherwise specified in Part 2, at 0·90 times the rated voltage or 0·90 times the lower limit of the rated voltage range, artificial cooling being used, if necessary.

**20.10.2.1** The test shall be made in addition to the above test, but controlled by an independent switching device.

**20.10.3** After the above tests, if applicable, the tool shall withstand the high voltage test, no connection shall have worked loose and there shall be no deterioration impairing safe and normal use. Handles, guards, brush caps and other fitting or component parts shall not have worked loose.

**20.11 Stability** — The tools which do not have provision of efficiently securing them to their support are tested by placing the tool in the most unfavourable position on the plane inclined at an angle of 15° to the horizontal. The tool shall not overturn.

### 20.12 Mechanical Strength

**20.12.1** The mechanical strength is checked by the tests given in **20.12.2** and **20.12.3** to meet the requirements of **20.12.4**.

**20.12.2** *Spring Operated Impact Test Apparatus*

**20.12.2.1** The apparatus consists of three main parts, the body, the striking element and the spring loaded release cone.

**20.12.2.2** The body comprises the housings, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1 250 g.

**20.12.2.3** The striking element comprises the hammer head, the ~~hammer~~ shaft and the cocking knob. The mass of this assembly is 250 g.

**20.12.2.4** The hammer head has a hemispherical face of polyamide having a Rockwell hardness of R100, with a radius of 10 mm; it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone when the striking element is on the point of release, is equal to the value shown in **20.12.2.7** for the compression.

**20.12.2.5** The cone has a mass of 60 g and the cone spring is such that it exerts a force of 20 N and when the release jaws are on the point of releasing the striking element.

**20.12.2.6** The hammer spring is such that the product of the compression, in millimetres, and the force exerted, in newtons, equals 1 000, the compression being approximately 20 mm.

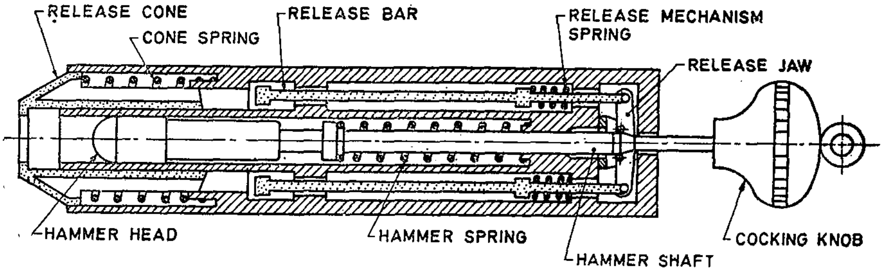

FIG. 2 SPRING OPERATED IMPACT TEST APPARATUS

**20.12.2.7** The compression of spring is adjusted so as to cause the hammer strike with an impact energy as follows:

| *Part to be Tested* | *Impact Energy* Nm | *Compression* mm |
|---|---|---|
| Brush caps | 0·5 ± 0·05 | 20·0 |
| Other parts | 1·0 ± 0·05 | 28·3 |

**20.12.2.8** The release mechanism springs are adjusted so that they exert just sufficient pressure to keep the release jaws in the engaged position.

**20.12.2.9** The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft.

**20.12.2.10** The blows are applied by pushing the release cone against the sample, in a direction perpendicular to the surface at the point to be tested. The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike. The sample as a whole is rigidly supported and three blows are applied to every point of the enclosure that is likely to be weak. If necessary the blows are also applied to handles, levers, knobs and the like.

**20.12.3** *Impact Test* – The tool is allowed to hit a steel plate, 5 mm thick and mounted on a rigid well, as shown in Fig. 3.

**20.12.3.1** For tools fitted with a non-detachable flexible cable or cord, the cable or cord is clamped at a point 1 m above the centre of gravity of the tool. Tools provided with an appliance inlet are suspended by a string, fastened to its handle.

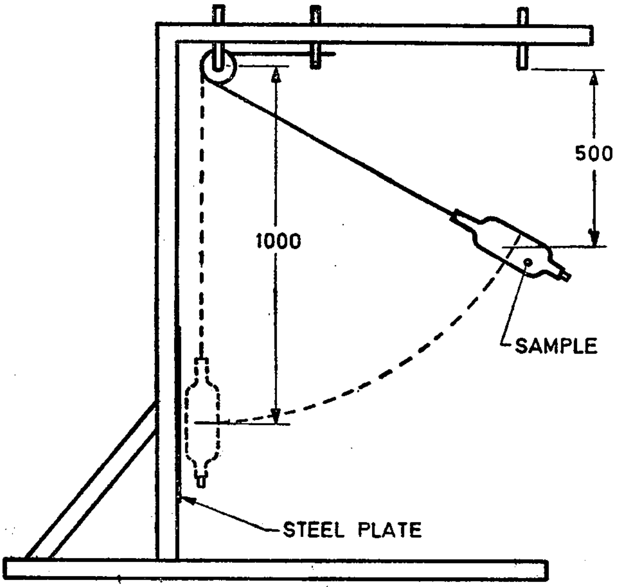

FIG. 3 ARRANGEMENTS FOR IMPACT TEST

**20.12.3.2** The tool is drawn away from wall in a plane perpendicular to the wall until the centre of gravity of a tool is 0·5 m above its original position. The tool is then allowed to hit freely against the steel plate.

**20.12.3.3** The test is made four times, the tool being turned each time to another position.

**20.12.4** After the test as above, the tool shall withstand high voltage test and shall show no damage impairing the safety of the tool. In particular, live parts shall not have become accessible when tested with test finger ( *see* **20.3** ), enclosures shall not have cracked or distorted so that creepage distances and clearances are below the values specified in **18** and insulating barriers shall not have been damaged.

Handles, levers, etc, shall not have moved on their shafts.

**20.12.4.1** Small pieces which may have become detached shall be ignored, provided the safety of the tool is not affected. Cracks which are not visible to the naked eye and surface cracks in fibre reinforced mouldings and the like shall be ignored.

### 20.13 Abnormal Operation

**20.13.1** Tools provided with motors having a locked rotor torque smaller than the normal load torque, are connected for 30 seconds to rated voltage or to the upper limit of the rated voltage range, starting from cold, with the moving parts locked.

**20.13.1.1** During this test the temperature-rise of the windings shall not exceed 1·70 times the temperature-rise permitted according to **13**.

**20.13.2** Tools other than hand-held tools for intermittent operation, shall be run continuously at the rated voltage or the upper limit of the rated voltage range with no load, until a steady temperature is attained.

**20.13.2.1** During this test the temperature-rise of the windings shall not exceed 1·70 times the temperature-rise permitted according to **13**.

**20.13.3** Tools with motors having capacitors in an auxiliary winding circuit shall be connected for 30 seconds to the rated voltage or the upper limit of the rated voltage range, at ambient temperature, with the capacitors short-circuited.

**20.13.3.1** During the test, the temperature-rise of the windings shall not exceed 1·70 times the temperature-rise permitted according to **13**.

**20.13.4** Tools with series motors shall be connected to 1·30 times the rated voltage or 1·30 times the upper limit of the rated voltage range for 1 minute with no load.

**20.13.4.1** After the test the tool shall be fit for further use. Windings and connections shall not have worked loose.

**20.13.5** Tools incorporating electronic devices shall be so designed that, in the event of a failure, the speed does not increase to such an extent that this might result in a hazard.

**20.13.5.1** Tools incorporating electronic devices shall be checked by operating the tool for 1 minute, at a voltage equal to 1·3 times the rated voltage, under no load condition.

**20.13.5.2** The test is then repeated with the electronic devices short-circuited and again with the electronic devices open-circuited. During these tests, the tool shall show no defects within the meaning of this specification.

**20.13.5.3** If the tool incorporates a device for limiting the speed, should the electronic device fail to operate correctly, the tool is considered to have withstand the test if that device operates during the test.

**20.13.6** *Testing of Tools Having Reverse Speed Switch*

**20.13.6.1** The tool is operated at a voltage equal to rated voltage or to the upper limit of the rated voltage range with no load, the device for reversing the sense of rotation being in a position such that the rotor rotates in one direction at full speed. The device is then placed in the position in which the sense of rotation is reversed, without stopping in an intermediate 'OFF' position.

**20.13.6.2** This sequence of operation is performed 25 times.

**20.13.6.3** During the test, no electrical or mechanical failure of the device and no burning or undue pitting of the contacts shall occur. After the test, the tool shall show no damage within the meaning of this specification.

### 20.14 Supply Connection

**20.14.1** *Cord Grip* — The test is made with a flexible cord supplied with the tool and provided with the cord guard, the cord grip being fitted normally.

**20.14.1.1** The conductors are introduced into the terminals and the terminal screws, if any, are tightened to the extent that the conductors do not easily be displaced or removed from that position. It shall not be possible to push the cord into the tool to any appreciable extent.

**20.14.1.2** The cord is then subjected 100 times to a pull without jerks equal to three times the mass of the tool, except that the pull shall be not less than 60 N or greater than 200 N. Pull shall be applied gradually and maintained for a period of 1 second.

**20.14.1.3** Immediately afterwards the cord shall be subjected for a period of 1 minute to a torque.

| *Mass of Tool*<br>kg | *Pull*<br>N | *Torque*<br>Nm |
|---|---|---|
| Up to and including 1 | 30 | 0·10 |
| Over 1 up to and including 4 | 60 | 0·25 |
| Over 4 | 100 | 0·35 |

**20.14.1.4** During the test no damage shall be caused to the flexible cord. At the end of the test, the cord shall not have been displaced by more than 2 mm and the ends of the conductors shall not have moved noticeably in the terminals. In order to enable the displacement to be measured, before starting the test a mark is made on the cord or cable under strain at a distance of approximately 2 cm from the cord grip. At the end of the test, the displacement of this mark in relation to the cord grip is measured while the cord or cable is still under strain.

**20.14.1.5** In addition, the cord grip is tightened and loosened 10 times with the largest flexible cord that can be introduced through the cord guard specified in **15.5**.

The cord grip shall show no damage.

**20.14.2** The cord guard is deemed to be reliably fixed if it does not become free during the test of **20.14.1** and during the test in **20.14.2.1**.

**20.14.2.1** The part of the tool comprising the cord entry, fitted with the cord guard and the flexible cord for which the tool is designed, is fixed in an apparatus similar to that shown in Fig. 4 so that when the oscillating member of the apparatus is at the middle of its travel the axis of the flexible cord, where it leaves the cord guard, is vertical and passes through the axis of oscillation. A weight equal to the mass of the tool, but not less than 2 kg or more than 6 kg is attached to the cord.

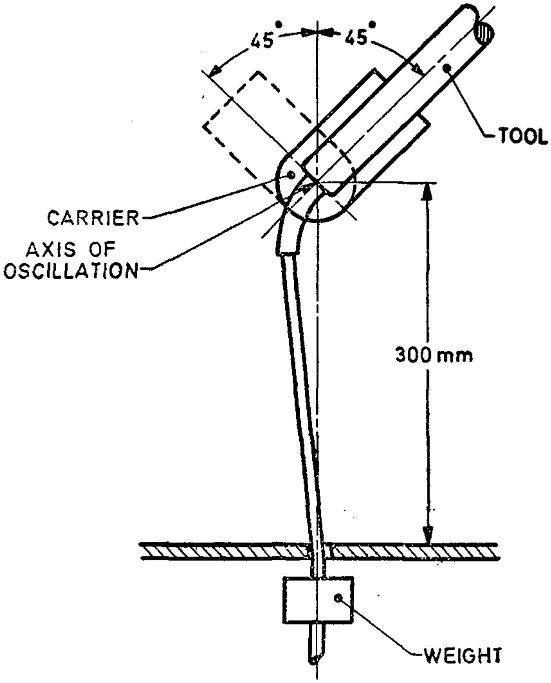

Fig. 4 Flexible Cord Guard Test Apparatus

The oscillating member is moved backwards and forwards through an angle of 90° ( 45° on either side of the vertical ), the number of flexings being 20 000 and the rate of flexing 60 per minute. After 10 000 flexings the sample is rotated through 90° about the centre-line of the cord guard, and the remaining 10 000 flexings are completed in the plane. A flexing shall be considered as one movement either backwards or forwards.

After the test the cord guard shall not have worked loose and neither the cord guard nor the flexible cord shall show any damage within the meaning of the specification, except that not more than 10 percent of the total number of conductor strands may have been broken.

### 20.15 Screws and Connections

**20.15.1** The screws and nuts which may be operated in the normal use shall be tightened and loosened by means of a suitable test screwdriver applying a torque as indicated in Table 9. The screw shall not be tightened in jerks. The number of loosening and tightening operations shall be as follows:

a) 10 times for screws in engagement with a thread in insulating material, and

b) 5 times in all other cases.

TABLE 9 TORQUE VALUES FOR SCREWED CONNECTIONS

| NOMINAL DIAMETER OF SCREW ( *see* IS : 4218* ) | TORQUE | |
|---|---|---|
| | Screw Without Heads† | Other Screws |
| mm | N m | N m |
| 3 | 0·25 | 0·50 |
| 3·5 | 0·40 | 0·80 |
| 4 | 0·70 | 1·20 |
| 5 | 0·80 | 2·00 |
| 6 | — | 2·50 |

*ISO metric screw threads ( Parts 1 to 6 ).

†This also includes screws which do not protrude from the holes when tightened.

**20.15.1.1** Where either or both of the threaded parts are non-metal, the screws shall be completely removed and reinstated each time.

**20.15.1.2** When testing terminal screws, a flexible conductor of the largest cross-sectional area appropriate to the tool rating is placed in the terminal. The conductor shall be moved each time the screw is loosened.

**20.15.2** During the test no damage impairing the further use of the screwed connections shall occur.

### 20.16 Resistance to Heat

**20.16.1** The enclosures and other external parts are subjected to a ball pressure test by means of the apparatus shown in Fig. 5.

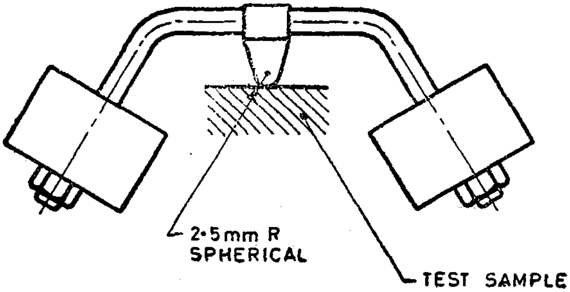

FIG. 5 BALL-PRESSURE APPARATUS

**20.16.1.1** The surface of the part to be tested is placed in the horizontal position and a steel ball of 5 mm diameter is pressed against the surface by a force of 20 N.

**20.16.1.2** The test is made in a heating cabinet at a temperature of 85 ± 2°C or 40 ± 2°C plus the temperature-rise of the relevant part determined during the temperature-rise test, whichever is the higher.

**20.16.1.3** After one hour the ball is removed and the diameter of the impression measured. The diameter shall not exceed 2 mm.

**20.16.2** Insulating parts retaining live parts in position shall be resistant to abnormal heat and to fire.

**20.16.2.1** The compliance is checked by a test as given in **20.16.1** but at a temperature of 125 ± 2°C or at a temperature which is 40 ± 2°C in excess of the temprature-rise of the relevant part determined during the temperature-rise test ( **20.5** ) whichever is higher.

**20.16.2.2** In addition, the insulating parts are subjected to a test made with an electrically heated conical mandrel in an apparatus shown in Fig. 6.

**20.16.2.3** The mandrel is inserted into a conical hole reamed in the part to be tested in such a way that portions of the conical part of the mandrel of equal length protrude from both sides. The sample is pressed against the mandrel with a force of 12 N. The means by which the force is applied is then locked to prevent any further movement.

**20.16.2.4** The mandrel is heated to a temperature of 300°C in approximately 3 minutes and is maintained within 10°C of this value for 2 minutes. The temperature is measured by means of a thermocouple inside the mandrel.

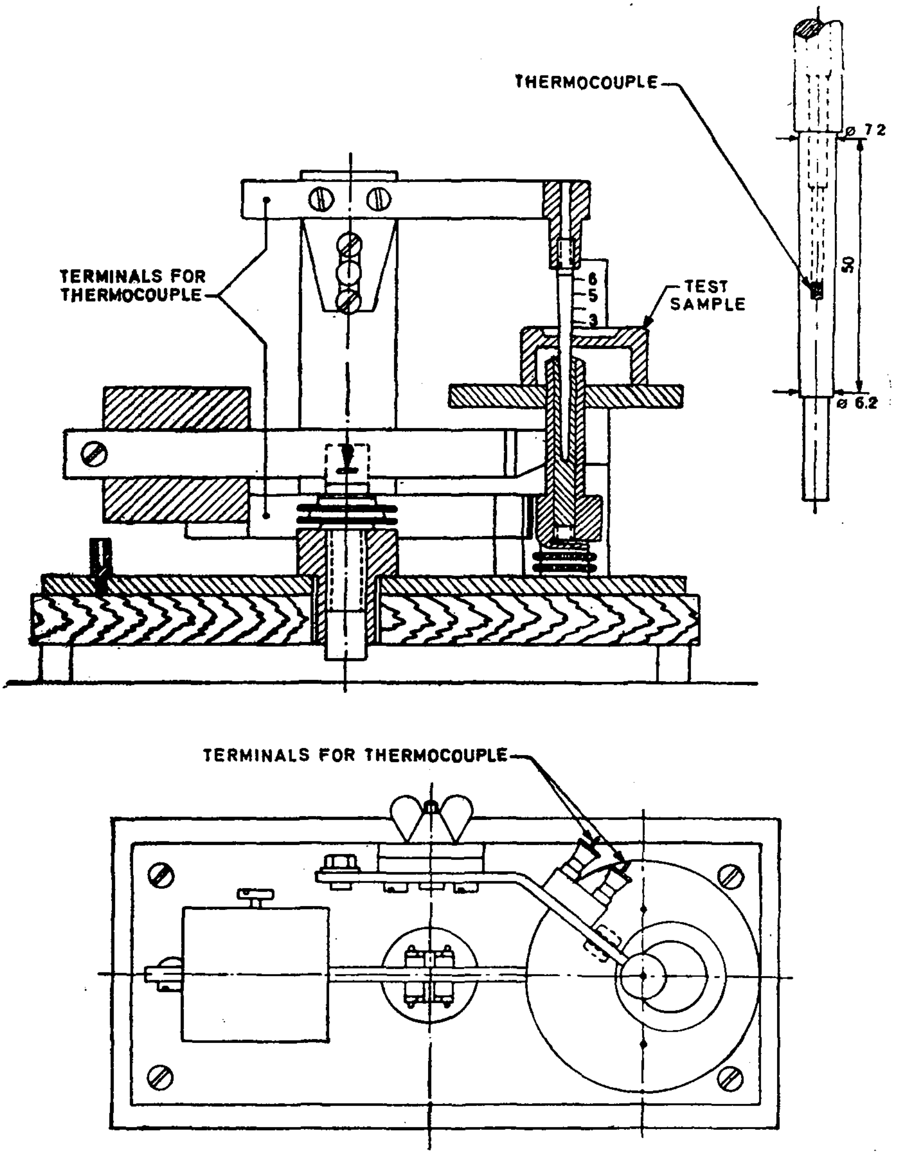

FIG. 6 HOT MANDREL APPARATUS

**20.16.2.5** During the test, sparks of about 6 mm in length are produced at the upper surface of the sample where the mandrel protrudes by means of a high frequency spark generator.

**20.16.2.6** Neither the sample nor any gases produced during the heating shall be ignited by the sparks.

**20.16.2.7** The tests are not made on parts of ceramic material, insulating parts of commutators or brush-caps and the like, or on coil formers not used as reinforced insulation.

**20.16.3** *Alternative Method* — Fire resisting property can also be determined by subjecting the material to the test specified in Appendix B.

### 20.17 Resistance to Tracking

**20.17.1** Insulating parts retaining live parts in position and supplementary insulation of metal-encased Class II tools shall be of material resistant to tracking, if they are exposed to excessive deposition of moisture or dirt in normal use, unless the creepage distances are at least equal to twice the values specified in **18.**

The tracking index shall be determined in accordance with IS : 2824-1975* the test voltage being 175 V. No flash over or breakdown between the electrodes shall occur before the fall of 50 drops of the electrolyte.

**20.17.2** The test is made on materials other than ceramic, brush caps and commutator insulating material.

### 20.18 Resistance to Rusting

**20.18.1** All ferrous parts shall be subjected to the following test.

**20.18.1.1** All grease is removed from the parts to be tested, by immersion in carbon tetrachloride for 10 minutes. The parts are then immersed for 10 minutes in a 10 percent solution of ammonium chloride in water at a temperature of 27 ± 5°C.

**20.18.1.2** Without drying, but after shaking off any drops, the parts are placed for 10 minutes in a box containing air saturated with moisture at a temperature of 27 ± 5°C.

**20.18.1.3** After the parts have been dried for 10 minutes in a heating cabinet at a temperature of 100 ± 5°C, their surfaces shall show no sign of rust.

**20.18.1.4** Traces of rust on sharp edges and a yellowish film removable by rubbing are ignored.

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*Method for determining comparative tracking index of solid insulating materials under moist conditions ( *first revision* ).

# APPENDIX A

( *Clause* 20.2.2.1 )

## SAMPLING PROCEDURES FOR ACCEPTANCE TESTS

### A-1. LOT

**A-1.1** In a consignment, all the tools of the same rating, model and type, manufactured from the same material under similar conditions of production shall be grouped together to constitute a lot.

**A-1.2** The number of tools to be selected from each lot shall depend upon the size of the lot and shall be in accordance with cols 1 and 2 of Table 10.

TABLE 10 SAMPLE SIZE, ACCEPTANCE NUMBER AND REJECTION NUMBER

( *Clauses* A-1.2 *and* A-2.1 )

| LOT SIZE $N$ (1) | FIRST STAGE $n$ (2) | SECOND STAGE $n$ (3) | ACCEPTANCE NUMBER $a$ (4) | FIRST REJECTION NUMBER $r_1$ (5) | SECOND REJECTION NUMBER $r_2$ (6) |
|---|---|---|---|---|---|
| Up to 50 | 5 | 5 | 0 | 2 | 2 |
| 51 ,, 100 | 8 | 8 | 0 | 2 | 2 |
| 101 ,, 300 | 13 | 13 | 0 | 2 | 2 |
| 301 ,, 500 | 20 | 20 | 0 | 3 | 4 |
| 501 and above | 32 | 32 | 1 | 4 | 5 |

**A-1.2.1** These tools shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS : 4905-1968* may be followed.

### A-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

**A-2.1** All the tools selected at the first stage in accordance with cols 1 and 2 of Table 10 shall be subjected to acceptance tests. A tool failing to satisfy any of the requirements of acceptance tests shall be termed as 'defective'. The lot shall be considered as conforming to the requirements of acceptance tests if the the number of defectives is less than or equal to the acceptance number 'a' in col 4 and shall be rejected if it is equal to or greater than the first rejection number ( $r_1$ ). If the number of defectives is greater than the acceptance number but less than the first rejection number, a second sample of the same size '$n_2$' as taken in the first stage, shall be selected from the lot at random and subjected to the acceptance tests. The number of defective in the first stage and the second stage shall be combined. If the combined number of defectives is less than second rejection number ( $r_2$ ), the lot shall be considered as conforming to the requirements of acceptance tests otherwise not.

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*Methods for random sampling.

# APPENDIX B

( *Clause* 20.16.3 )

## TEST FOR FIRE-RESISTING PROPERTIES

### B-1. PREPARATION OF SAMPLE

**B-1.1** The specimen shall consist of a portion broken from the moulding and shall weigh not less than 6 g nor more than 10 g, and shall be not more than 10·0 mm in the thickness measured from an externally cured face.

### B-2. APPARATUS

**B-2.1** The specimen shall be tested in the heating tube of an apparatus of the general type, shown in Fig. 7, the pilot flame being located 20 mm above the upper end of the specimen.

**B-2.2** A support for the specimen shall be provided in the heating tube and this may suitably consist of a light stirrup of nichrome wire, supported by a length of nichrome wire passing over the pilot flame tube. The support shall be such that the specimen is fixed centrally in the heating tube, with its largest dimension vertical.

**B-2.3** The apparatus shall be heated by passing a suitably regulated electric current through a nichrome resistance wire surrounding the heating tube.

**B-2.4 Measurement of Temperature of Tube** — The temperature of the tube shall be taken as shown by a thermocouple situated at the level of the centre of the specimen and equidistant from the inner surface of the heating tube and the specimen. The wires of which the thermocouple is made shall be not larger than 1·25 mm and not smaller than 0·462 mm in diameter and shall be bare for a length of 25 mm from the junction.

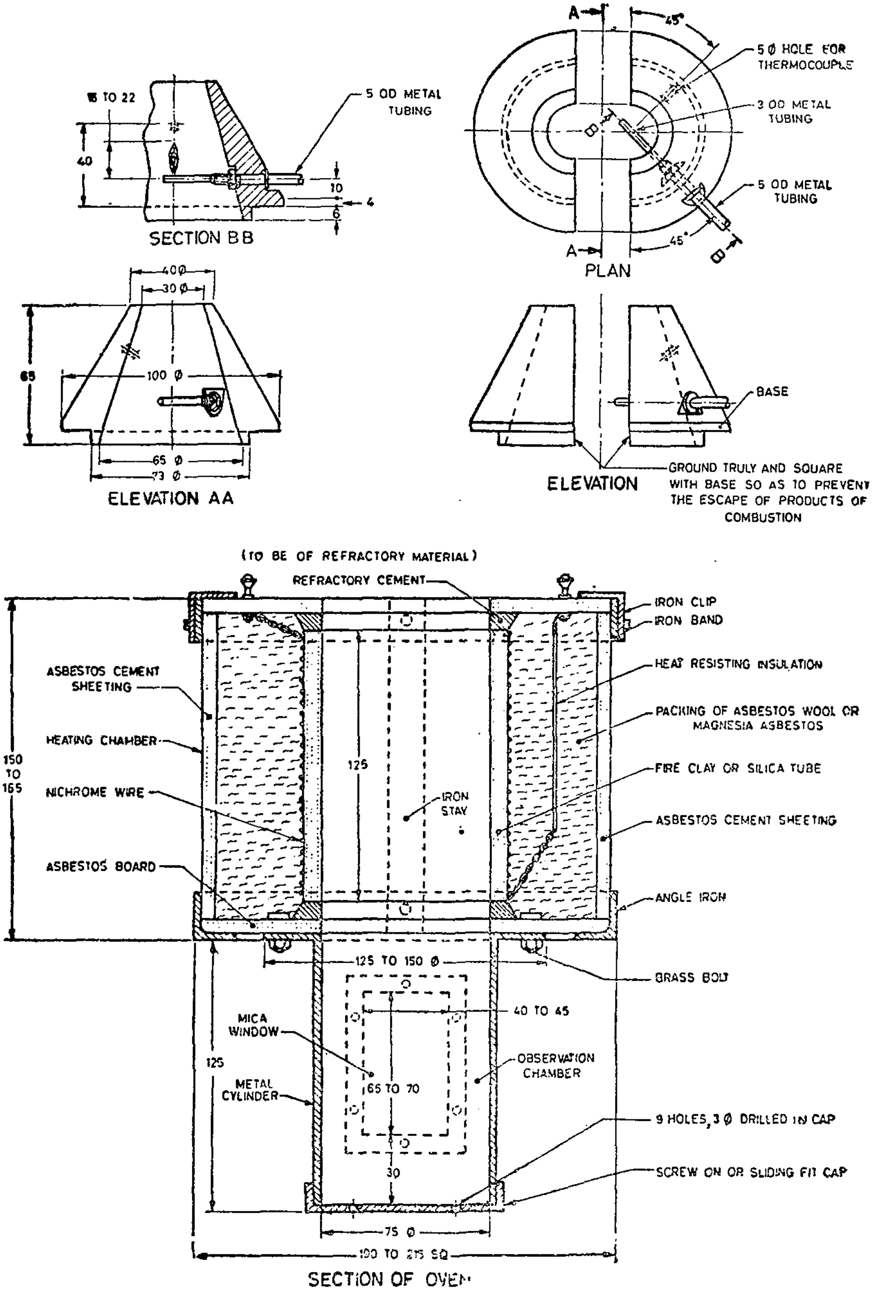

FIG. 7 APPARATUS FOR NON-FLAMMABILTTY TEST

## B-3. TEST FOR FLAMMABILITY

**B-3.1** The temperature of the tube shall be raised to 300°C and the specimen shall be inserted in the tube. The temperature shall then be readjusted to 300°C within a period of 3 minutes, and this temperature shall be maintained until a period of 5 minutes has elapsed from the time of insertion of the specimen. During this period a conical cover at the top shall limit the opening to approximately 6·5 $cm^2$ while the air intake orifice at the bottom shall be open approximately 0·65 $cm^2$. At the end of the period of 5 minutes, the specimen shall be removed from the tube. The material shall not be deemed non-flammable if at any time during the test, the specimen flames or gives off flammable vapours in sufficient quantities to ignite at the pilot flame.

( *Continued from page* 2 )

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